

THE CEPHALOPODA OF MADEIRA

RECORDS AND DISTRIBUTION

By W. J. REES AND G. E. MAUL

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SYNOPSIS

The cephalopod fauna of Madeira is revised and no fewer than 22 additional species are added to the list, chiefly on account of the examination of the stomach contents of *Alepisaurus ferox* Lowe, *Aphanopus carbo* Lowe and the sperm whale. A total of 18 species (many of them rare and seldom taken in the nets of deep sea expeditions) are recorded from *Alepisaurus ferox*. The following little known species have been found in the stomachs of sperm whales at Madeira: *Tetronychoteuthis dussumieri* (Orbigny), *Lepidoteuthis grimaldi* Joubin and *Architeuthis* sp. The composite fauna is analysed and compared with that of the Mediterranean.

I. INTRODUCTION

THIS preliminary paper on the cephalopod fauna of Madeira has its origins in an investigation of the stomach contents of the voracious fish, *Alepisaurus ferox* Lowe. The work at Madeira was pursued for some years prior to the despatch of all the cephalopoda taken (together with representative local collections) to the British Museum (Natural History) for identification. The material yielded many species scarce in collections and it was deemed an opportune time to produce a new list of Madeiran cephalopods.

This list is rich in the names of seldom-recorded species, chiefly because the fishes *Alepisaurus ferox*, *Aphanopus carbo* Lowe and the sperm whale have been examined for stomach contents. The occurrence of the various rare species are noted in the main part of the text, but special attention is drawn to the records of *Lepidoteuthis grimaldi* Joubin, *Tetronychoteuthis dussumieri* (Orbigny), *Histioteuthis bonelliana* (Férussac) and *Architeuthis* from the sperm whale.

In this preliminary paper we have not given full descriptive accounts of the species found ; this is reserved for further accounts of interesting species either jointly or independently.

II. A SUMMARY OF PREVIOUS RECORDS

The first record of a cephalopod to be recorded in scientific literature from the vicinity of Madeira was of a Taonid which d'Orbigny referred to *Loligopsis pavo* Lesueur in the great *Histoire des céphalopodes acetabulifères* (1835-1848). It was later pointed out by Rochebrune (1884) and Hoyle (1884) that d'Orbigny had confused two species under this name and the Madeiran specimen (taken in sight of Madeira by the naturalist Dussumier) was redescribed by the former under the name *Phasmatopsis cymoctypus*.

Robert MacAndrew, who dredged extensively on the coast of Spain and Portugal, both in the Atlantic and in the Mediterranean, does not mention a single cephalopod from his dredgings at Madeira (1849-50).

White and Johnson, in their *Handbook of Madeira* (1860) list the following six species :

- Loligo vulgaris* Lamarck.
- Sepia officinalis* L.
- Octopus vulgaris* Lamarck.
- Octopus cuvieri* (= *O. macropus* Risso).
- Argonauta argo* L.
- Ocythoë tuberculata* Rafinesque.

In their second edition (1885) the fourth and last species are not listed. Hoyle (1885, p. 69) confirmed the occurrence of *Argonauta argo* at Madeira in his Challenger Report.

More species were added to the list by Girard (1892) who reported on the collections of the Abbé Ernest Schmitz of the Seminário do Funchal, adding or confirming the existence of the following at Madeira :

- Loligo forbesi* Steenstrup.
- Spirula peronii* Lamarck¹ (= *Spirula spirula* L.).
- Sepia filliouxii* Lafont (= *S. officinalis*).
- Todarodes sagittatus* (Lamarck).
- Ocythoë tuberculata* Rafinesque.
- Octopus tuberculatus* Blainville.²

Girard was aware of the differences between *L. vulgaris* and *L. forbesi* and as the species submitted to him by Schmitz proved to be *L. forbesi*, the former species was dropped from the list ; nor was he able to confirm the existence of *O. macropus* in the area.

¹ Apparently empty shells.

² Presumed here to be a juvenile specimen of *O. vulgaris*.

Watson (1897) added no new species to the list of Madeiran cephalopods but confirms that *O. vulgaris* is a common species and states that *Sepia officinalis* is rare.

From 1890 onwards the various deep sea expeditions have taken cephalopods in the N. Atlantic, sometimes near, sometimes some distance off Madeira, and the list compiled by Nobre (1937) includes 20 species of which several have been taken a considerable distance away and could not be termed local fauna. Some of the species which he records were taken as far west from Madeira as the African coast is to the east of it. The following species were taken too far away to be retained as local Madeiran records :

- Sepietta oweniana* (Orbigny).
- Onychia caribaea* Lesueur.
- Brachioteuthis riisei* (Steenstrup).
- Histioteuthis bonelliana* (Férussac).
- Taonius pavo* (Lesueur).
- Japetella diaphana* Hoyle.

As Girard's *Octopus tuberculatus* probably falls into the synonymy of *O. vulgaris*, Nobre's list becomes amended to 13 cephalopods known from the immediate vicinity of Madeira. To these may be added Joubin's record of *Leachia cyclura* (1920).

III. ADDITIONS TO THE FAUNA

The Madeiran archipelago has a much richer cephalopod fauna as our investigations have shown, and we do not think we have by any means exhausted the numbers of species which should occur off Madeira. A great many other cephalopods known from the central North Atlantic remain to be reported from this area. Below is given a list of 22 additional species which we are now recording from Madeira.

- Heteroteuthis dispar* (Rüppell).
- Loligo vulgaris* Lamarck.
- Abraliopsis morisii* (Verany).
- Enoploteuthis leptura* (Leach).
- Pyroteuthis margaritifera* (Rüppell).
- Cuciotheuthis unguiculata* (Molina).
- Tetronychoteuthis dussumieri* (Orbigny).¹
- Lepidoteuthis grimaldi* Joubin.¹
- Onychoteuthis banksi* (Leach).
- Architeuthis* sp.
- Histioteuthis bonelliana* (Férussac).
- Ommastrephes pteropus* Steenstrup.
- Thysanoteuthis rhombus* Troschel.
- Chirotheuthis veranyi* (Férussac).
- Mastigoteuthis schmidti* Degner.

¹ These two species are here recorded from the stomachs of sperm whales taken at Madeira. It is hoped to provide a full description in another paper.

- Taonius pavo* (Lesueur).
Cranchia scabra Leach.
Japetella diaphana Hoyle.
Eledonella pygmaea Verrill.
Vitreledonella richardi Joubin.
Alloposus mollis Verrill.
Tremoctopus violaceus delle Chiaje.

Family SPIRULIDAE

Spirula spirula L.

Spirula peronii, Girard, 1892, p. 219; Watson, 1897, p. 318, Nobre, 1937, p. 5.

This species is known only from the dead shells at Madeira; these are cast up on the beaches of Porto Santo occasionally and are also known from Caniçal (Girard). Bruun (1943) reporting on the living *Spirula* captured by the "Dana" expeditions, believed that this species inhabits the continental slope, living at depths not exceeding 1750 metres.

Family SEPIIDAE

Sepia officinalis L.

Sepia officinalis, White & Johnson, 1860; Johnson, 1885; Watson, 1897, p. 316; Nobre, 1937, p. 5.

Sepia fillouxii, Girard, 1892, p. 219.

Material seen :

1 specimen, dorsal mantle length of 205 mm. (Maul collection No. 144).

According to Watson (1897), *Sepia officinalis* is rare at Madeira, but the species is very common all the year round at Madeira and adult specimens measuring about 25 cm. (in dorsal mantle length) are often seen at the local fish market. The species goes by the name of *Chouco* and is eaten by the local population.

Family SEPIOLIDAE

Heteroteuthis dispar (Rüppell)

Material seen : All except No. 3281 from the stomachs of *Alepisaurus ferox*.

No. 3281, 1 mutilated specimen, dorsal mantle length 20 mm. from the stomach of *Aphanopus carbo*, 10.i.51.

No. 3365, 1 specimen, dorsal mantle length 25 mm., 10.iv.1952.

No. 3490, 4 specimens, dorsal mantle lengths of 25, 28, 29 and 20 mm.—no date.

No. 3802, 1 specimen, dorsal mantle length of 22 mm.—no date.

No. 3848, 2 specimens, dorsal mantle lengths of 8 and 12 mm.—no date.

This sepiolid has not previously been taken at Madeira, and although reported from numerous stations in the Mediterranean (Degner, 1925). it has been found on comparatively few occasions in the Atlantic. Each major expedition has, however,

secured specimens; those found nearest to Madeira being those captured by the "Talisman" (29° 2' N., 14° 49' N.) between the Canaries and the African coast (Fischer & Joubin, 1907), and those of the "Thor" from just outside the Straits of Gibraltar (Degner, 1925). *Heteroteuthis dispar* is often regarded as a deep sea cephalopod, but it is difficult to justify this claim, which seems to be based on the fact that the species has a luminous secretion. To quote Harvey (1952, p. 283): "It is sometimes said that the luminous secretion of deep sea *Heteroteuthis* has replaced the ink of surface dwellers. This black fluid forms a poisonous smoke screen which confounds the enemy while the squid makes a getaway. Although it is not true that the luminous secretion has completely replaced the ink, it may serve a similar purpose—to draw the attention of the enemy to a mass of lighting material, while the squid moves off in another direction." However, an examination of Degner's details of capture in the Mediterranean and Atlantic shows that captures were more frequent with only 300 metres of wire out than in deeper hauls, and it can be reasonably assumed that the net was fishing at only half or less than half this depth. The fact that *Heteroteuthis* has retained its ink sac is also an indication that it can and does live above the threshold of light. Whether it can also live below the threshold of light is so far unknown. As an item in the food of *Alepisaurus ferox*, it probably occurs at the depths at which this fish is taken on tunny hooks at Madeira. It is also a regular item in the diet of the long-finned albacore (*Germo alalunga*) in the Bay of Biscay (Bouxin & Legendre, 1936, p. 36), and it has been reported from the stomach of the dolphin (*Delphinus delphis*) by Joubin (1900, p. 10).

Sepietta oweniana (Orbigny)

Sepiolo scandica, Fischer & Joubin, 1906, p. 204.

Sepietta oweniana, Bouxin & Legendre, 1936, p. 32; Nobre, 1937, p. 5.

Material seen:

No. 2812, 2 specimens, dorsal mantle lengths of 12 and 17 mm., Funchal Harbour, 12.iii.1943.

The "Travailleur" took this species in position 32° 40' N., 18° 54' W., some distance to the south-west of Madeira. Its occurrence at Madeira is confirmed from two specimens we have seen.

Family LOLIGINIDAE

Loligo vulgaris Lamarck

Material seen:

No. 2966, 1 juvenile, no data.

No. 3164, 5 juveniles from Funchal Harbour, 4.v.1950.

No. 3848, 1 juvenile, dorsal mantle length of 7 mm. from stomach of *Alepisaurus ferox*.

The specimens from Funchal Harbour are juveniles of only 30–35 mm. in dorsal mantle length. *Loligo vulgaris* is recorded as far north as the coast of Denmark,

but it is doubtful whether it breeds anywhere north of the latitude of Ushant at the mouth of the English Channel. As a Lusitanian species it is well known in the Mediterranean and on the Mauritanian coast, while recently Adam (1952) has demonstrated that it occurs off the Congo and as far south as Algoa Bay. It has been reported from the Canary Islands (Odhner, 1931) and, although said to occur at the Azores (Drouet, 1858), its presence there requires confirmation.

Loligo forbesi Steenstrup

Loligo forbesii, Girard, 1892, p. 219; Nobre, 1937, p. 6.

No. 4355, Funchal Market 1 ♂ of 270 mm. in dorsal mantle length.

Girard based his identification of this species on many examples sent to him by the Abbé Ernest Schmitz of Funchal. This species has often been reported from the neighbouring African coast. Locally, *Loligo* goes by the name of *Lula da costa*, but it is not known whether the two species are confused under this name. It is very common in winter, and as an article of food stands next to *O. pteropus* in importance. Market specimens range from about 200 mm. to 500 mm. in dorsal mantle length.

Abralia veranyi (Rüppell)

Abralia veranyi, Berry, 1926, p. 257.

Abralia veranyi, Nobre, 1937, p. 7.

Material seen :

No. 2664, 1 specimen of 47 mm. dorsal mantle length, Funchal Harbour, at night, 16.x.1941.

No. 2964, no data—5 specimens, 37–50 mm. in dorsal mantle length.

No. 3514, Funchal Museum (no date).

This luminous squid is a Mediterranean-Atlantic species; most of the records of its occurrence are from the Mediterranean (Messina, Nice, Genoa, Naples and Toulon), while in the Atlantic (apart from Madeira) it has been found at comparatively few places, viz: Cockburn Town, San Salvador Island (Adam, 1941) and off the Congo (Adam, 1952).

These specimens provide additional records for Madeira. No. 3514, a male, has the left ventral arm hectocotylyzed just as figured by Adam (1952, p. 63, fig. 25E). This specimen has a dorsal mantle length of 42 mm. One of the female specimens (Lot No. 2964) has a dorsal mantle length of 50 mm.; this is considerably bigger than Adam's largest specimens, which were up to about 40 mm. in dorsal length (Adam, 1952, p. 70).

Abraliopsis morisii (Verany)

Material seen :

No. 3848, 6 specimens of 8–25 mm. in dorsal mantle length from the stomach of *Alepisaurus ferox*.

This is the first time this small luminous squid has been recorded from Madeira and from the stomach of *Alepisaurus ferox*. Records of this species from the Mediterranean and the Atlantic are fairly numerous (see Chun, 1910).

Enoploteuthis leptura (Leach)

Material seen :

No. 2664, Funchal Harbour at night, 16. x. 1941, 1 specimen.

No. 2963, Madeira, 1 specimen, no data.

No. 3487, Funchal Harbour at night, 1. vi. 1946, 1 specimen.

These are the first Madeiran records of this rather scarce cephalopod. It is known from the African coast and Pacific (Férussac & d'Orbigny, 1835-1848) and a juvenile from the Atlantic (position $0^{\circ} 29' N.$, $18^{\circ} 57' W.$) was captured by the Deutsche Südpolar-Expedition and figured by Chun (1910, Taf. xl, figs. 5 and 6) in the "Valdivia" report.

Pyroteuthis margaritifera (Rüppell)

Material seen :

No. 2961, 2 specimens, dorsal mantle length of 35 mm., from stomach of *Alepisaurus ferox*, March and April, 1944.

This is another well known Mediterranean-Atlantic, luminous cephalopod. Joubin (1924, p. 52) reported it from the Azores but it does not seem to have been recorded from Madeira, neither has it been recorded as an item in the diet of *Alepisaurus ferox*. The "Thor" took specimens in the Eastern Mediterranean with 200-300 metres of wire out, so that the species can be assumed to exist up to 100 metres of the surface.

Family OCTOPODOTEUTHIDAE

Cuciotheuthis unguiculata (Molina)

Cuciotheuthis unguiculata, Joubin, 1900, p. 51; Nobre, 1937, p. 6.

The "Princess Alice" took this species in position $32^{\circ} 32' 10'' N.$, $19^{\circ} 24' 40'' W.$, to the west of Madeira. There is a large brachial crown, in the Municipal Museum, Funchal, from a specimen which was found dead floating at the surface near the shore to the west of Funchal.

Onychia caribaea Lesueur

Teleoteuthis jattai Joubin, 1900, p. 67.

Teleoteuthis caribaea, Nobre, 1937, p. 7.

Nobre includes this species in his list of Madeiran cephalopods, but the position at which this species was taken by the "Princess Alice" (1897) Cruise, St. 812, $31^{\circ} 04' N.$, $27^{\circ} 11' W.$) is nearly as far to the south-west of Madeira as these islands are from the African coast. The species must therefore be omitted from the list.

Onychoteuthis banksi (Leach)

Material seen :

- No. 2455, no data, 1 specimen of 100 mm. in dorsal mantle length.
 No. 3507, no data, 1 specimen of 130 mm. in dorsal mantle length.
 No. 2965, no data, 1 poorly preserved specimen of 35 mm. dorsal mantle length.
 No. 3571, 1 specimen of 48 mm. dorsal mantle length, from stomach of *Alepisaurus ferox*, 4.xii.1952.
 No. 3848, 45 specimens, dorsal mantle lengths of 10, 13, 21-24 mm., stomach of *Alepisaurus ferox*.
 No. 3509, 1 mutilated juvenile, dorsal mantle length 24 mm., from the stomach of *Alepisaurus ferox*.

Onychoteuthis banksi is here recorded for the first time from Madeira. No. 2965 is in poor condition and only provisionally referred to this species.

This is a well-known oceanic surface species which, in the neighbourhood of Madeira, was taken in position 30° 54' N., 24° 11' N., by the Prince of Monaco in his 1912 cruise (Joubin, 1924, p. 48). Other nearby records for the "Terra Nova" and the "Ara" are given by Rees (1949, p. 43) who drew attention to the habit of "flying" in this species. New records of specimens being found on the deck of ships are given by Adam (1952, p. 77).

Family ARCHITEUTHIDAE

Architeuthis sp.

A sperm whale, harpooned off São Lourenço on 12th June, 1952, vomited a squid which had evidently just been swallowed because the latter still exhibited some signs of life. This squid was large, with a weight of 150 kilograms, and could only have been a species of *Architeuthis*. The following measurements were taken :

Overall length (i.e. including tentacles)	. . . . .	10,600 mm.
Dorsal mantle length	. . . . .	1,860 "
Length of tentacles	. . . . .	8,500 "
Length of arm	. . . . .	2,800 "
Circumference of mantle	. . . . .	1,360 "
Circumference of tentacles	. . . . .	330 "

Architeuthis was taken by the French steamer "Alécton" between Madeira and Teneriffe in November, 1860, and the species was subsequently given the name *Loligo bouyeri* by Crosse and Fischer (1862, p. 138). A number of species of *Architeuthis* have been described since Verrill's classical monograph and it is by no means certain how many kinds there are. Fragments of the above specimen are kept in the Museu Municipal, Funchal, and it is hoped to present a more detailed description in another paper.

Family HISTIOTEUTHIDAE

Histioteuthis bonelliana (Férussac)*Histioteuthis riippelli*, Joubin, 1900, p. 98.*Histioteuthis bonelliana*, Nobre, 1937, p. 6.

Material seen :

No. 3905, 1 specimen, dorsal mantle length of 53 mm., from stomach of
Aphanopus carbo, 30.x.1953.

Nobre records this species as Madeiran on the basis of an arm found in position 41° 0' N., 12° 15' W., by the "Princess Alice" in 1894 (Joubin); this position is off the north coast of Portugal, so that this could not be justified as a Madeiran record of this species. *Histioteuthis* does occur, however, around Madeira, as recorded above, and we are indebted to Mr. H. M. Sieyes for a photograph of a large brachial crown of this species found in the stomach of a sperm whale captured off São Laurenço lighthouse, Madeira on 12th June, 1952. It is interesting to note that this sperm whale feeds on this species at Madeira, as at the Azores and elsewhere. The specimen from the stomach of *Aphanopus carbo* was much smaller, with an overall length of about 170 mm. It is noteworthy that Verrill (1880, p. 234) recorded *H. bonelliana* from *Alepisaurus ferox* (as *H. collinsii*).

Family BRACHIOTEUTHIDAE

Brachioteuthis riisei (Steenstrup)*Tracheloteuthis riisei*, Joubin, 1924, p. 75.*Brachioteuthis* (*Tracheloteuthis*) *riisei*, Nobre, 1937, p. 6.

This wide-ranging surface cephalopod is included in the Madeiran fauna by Nobre on the strength of a record of capture of this species in position 31° 45' N., 20° 17' W., by the "Princess Alice" (Joubin). This is some distance south and west of Madeira, but such a widely distributed species is almost certain to be found in this area.

Family OMMASTREPHIDAE

Todarodes sagittatus (Lamarck)*Todarodes sagittatus*, Girard, 1892, p. 220.*Ommastrephes sagittatus*, Nobre, 1937, p. 8.

Material seen :

No. 3355, 1 juvenile, dorsal mantle length of 83 mm. from the stomach of
Alepisaurus ferox, 8.iv.1952.

No. 3356, 1 juvenile, dorsal mantle length 86 mm. from the stomach of
Alepisaurus ferox, 8.iv.1952.

No. 3363, 1 juvenile, dorsal mantle length 85 mm. from the stomach of
Alepisaurus ferox.

No. 4347, Funchal Market, 1 specimen of 185 mm. in dorsal mantle length.

Madeiran records in the literature are few and are based on the following specimens : 1 ♀ taken by Schmitz, 1 ♀ by Nunes. To these may be added the specimens from the stomach of *Alepisaurus ferox* noted above.

The sucker rings of the tentacles are mostly absent : the very long-sucker-bearing region of the tentacle, extending for the greater part of its length, the almost smooth, large tentacular rings and the presence of four rows of suckers near the tip of the tentacles indicate that the species is *T. sagittatus*. Locally *Todarodes* is called *Cartucho* ; it is extremely common on the fishing grounds in March, April and May. It is also taken during other months, but it is rare at these times.

As a common cephalopod on the fishing grounds of the eastern North Atlantic and the Mediterranean, *Todarodes* is preyed on by a number of animals, including the dolphin, *Delphinus delphis* (Joubin, 1895, p. 32), *Gerno alalunga* (Bouxin and Legendre, 1936) and *Gadus calliarias* (Michael Sars Stations 7, 86, 352 and 115). Joubin (1895, 1900, 1920 and 1924) also reported various ommastrephid fragments, some of which probably belong to this species, from *Polyprion americanum* and *Grampus griseus*.

Ommastrephes pteropus Steenstrup

Material seen :

- Nos. 65 and 66, 2 fragments, Funchal Harbour, 16.iv.1941.
- No. 193, 1 juvenile, dorsal mantle length 58 mm., 10.v.1940.
- No. 3443, 1 specimen, dorsal mantle length 270 mm.—no data.
- No. 3678, 1 juvenile, dorsal mantle length 50 mm. from stomach of *Alepisaurus ferox*, 25.iii.1953.
- D. W. Tucker Collection, No. 605, 1 juvenile, dorsal mantle length 80 mm.
- D. W. Tucker Collection, Nos. 639-644, 6 half-grown specimens, gaffed at night on Madeiran fishing grounds, August, 1953.

All these specimens have been referred to *O. pteropus* ; some of them might equally well have been referred to *O. bartrami* as we find that the diagnostic key given by Pfeffer (1912, p. 465) is unreliable and our specimens clearly belong to one species.

Adam (1952, p. 110) also noted the unreliable nature of the connective apparatus on the tentacles as a means of separating *bartrami* from *pteropus*. The number of suckers, proximal to the nearest connective button, will vary as new buttons develop with the growth of the tentacle, as indicated in one of our larger specimens where there is a rudimentary button ; this points to the great need for a revision of these species with more material than we have at our disposal.

The relationships of these two species to *Ommastrephes caroli* is equally puzzling. In the species *caroli* the lateral membrane is a broad triangular flap in adult specimens (Rees, 1950, pl. 1) while in younger specimens it is much narrower (see Hertling, 1938). Our specimens from Madeira (those of 2-3 ft. in total length) possess narrow lateral membranes on the third arms which might conceivably develop into the characteristic paper-thin flaps of *caroli*. As in the latter their chromatophores are closely set and a deep chestnut-brown in colour.

Ommastrephes pteropus is very abundant during the summer months of July, August and September and is extensively used for baiting the tackle for *Aphanopus carbo*, tunny and other fish. It is found in great numbers in locally caught *Germonobesus*. Large quantities of this squid, which goes under the local name of *Pota de limão* or *Lula de limão*, are sold in the fish market for consumption by the local people, who greatly appreciate it as food. The large, lemon-coloured dorsal mark has been observed to flare up with a bright light when the animal is gaffed.

Ommastrephids :

No. 2957, 1 juvenile, dorsal mantle length of 50 mm. from stomach of *Alepisaurus ferox*, March–April, 1944.

No. 3848, 3 juveniles, dorsal mantle length of 17, 20 and 25 mm. from the stomach of *Alepisaurus ferox*.

No. 193, 1 juvenile, dorsal mantle length of 65 mm. from the stomach of *Alepisaurus ferox*, 10. v. 1940.

These fragmentary specimens are in poor condition and we have not been able to identify them.

Thysanoteuthis rhombus Troschel

Material seen :

1 specimen, dorsal mantle length of 350 mm., taken at Funchal.

This is the first record of this powerful surface species from Madeira. Some years ago a school of about 20 came close inshore, and this is the only specimen it was possible to save for examination. Little is known about its distribution, but it occurs in the Mediterranean (Naef, 1923–1928) and has been reported from the Cape of Good Hope by Barnard (1934). It is likely, however, to be a cosmopolitan warm-water species, as Sasaki (1929) has recorded it from a number of localities in Japanese waters.

Chiroteuthis veranyi (Férussac)

Material seen :

No. 3685, 1 *Doratopsis* larva of 80 mm. in overall length. Coll. A. A. Nunes, 8. vii. 1948.

This larva was taken at the Pontinha at the surface at night in the light of an electric lamp suspended over the water.

It is a well-known Mediterranean-Atlantic species whose larva is frequently taken at places like Messina and Villefranche, where there is upwelling from deep water. The closely related species *Doratopsis exophthalmica* was taken by the "Valdivia" in position 31° 59' N., 15° 5' W. to the south-east of Madeira.

Published records of *C. veranyi* from the North Atlantic are few (see Adam, 1952, p. 111), but to judge from the number of specimens recovered from the stomachs of germon fished in the Bay of Biscay the species is not as rare as the absence of records suggests (Bouxin and Legendre, 1936).

Mastigoteuthis schmidti Degner

Material seen :

- 1 specimen, dorsal mantle length of 107 mm., from the stomach of *Alepisaurus ferox*, December, 1944.

There are no previous records of *Mastigoteuthis* from Madeira and this specimen is only provisionally referred to *M. schmidti* because we recognize the need for a complete revision of the large number of species described from the Atlantic. As regards the proportions of mantle and fin the species is very similar to *M. schmidti*.

Family CRANCHIIDAE

Leachia cyclura Lesueur

Leachia cyclura, Joubin, 1920, p. 68.

Material seen :

- No. 3513, 1 specimen, overall length 145 mm. from stomach of *Alepisaurus ferox*—no date.
 No. 3848, 1 juvenile, dorsal mantle length of 23 mm. from stomach of *Alepisaurus ferox*.

Leachia cyclura was taken by the Prince of Monaco on the fishing grounds of Madeira in 1901 (Stn. 1235, 8th September, 32° 34' N., 17° 45' W.). This species has rarely been captured in the Atlantic, and since it was described from the Atlantic coast of N. America by Lesueur (1821), it has been recorded by Joubin only from Madeira, the Azores and the Sargasso Sea. It is known from other oceans also.

Cranchia scabra Leach

- No. 3497a, 1 specimen, overall length of 110 mm. from stomach of *Alepisaurus ferox*.
 No. 3497b, 1 specimen, Funchal Harbour, at night.
 No. 3497c, 1 specimen, overall length 105 mm. from stomach of *Alepisaurus ferox*.

This species is well known from the sub-tropical and tropical areas of the Atlantic and other oceans, but does not appear to have been reported from Madeira. It is also recorded for the first time from the stomach of *Alepisaurus ferox*.

There is no particular reason for supposing that this species is a deep-water animal. Its presence in the upper 200 metres has been proved by the Deutsche Südpolar Expedition, which took specimens at 20 and 40 metres depth. It should be noted that records from 2,000 and 3,500 metres by the "Valdivia" were made with open nets (Chun, 1910).

Taonius pavo (Lesueur)

Taonius pavo, Joubin, 1900, p. 106; Nobre, 1937, p. 8.

Material seen :

No. 3902, 1 specimen without tentacles, partly macerated, from the stomach of *Alepisaurus ferox*, 26. xi. 1953.

This specimen agrees favourably with the specimen figured by Joubin (1900, p. 106, pl. viii and ix), but the colour is of a deep reddish purple. Our specimen has a dorsal mantle length of 275 mm. and a total length of 385 mm.

This example, from the stomach of *A. ferox*, is the first to be found at Madeira. The specimen taken by the Prince of Monaco in 1897 (Stn. 817, position 30° 42' N., 27° 32' W. was found well out in the Atlantic and a considerable distance from Madeira.

Taonius pavo has all the appearance of being a bathypelagic species, and we have wondered whether the occurrence of this squid (and also some others, notably, *Mastigoteuthis schmidti* and *Eledonella pygmaea*) in this fish can be explained by local upwelling of deep water bringing these species near the surface.

Taonius cymoctypus (Rochebrune)

Loligopsis pavo, Orbigny, 1835-1849, p. 321 (*pars*).

Phasmatopsis cymoctypus Rochebrune, 1884, p. 15, pl. 1.

Taonius pavo, Girard, 1892, p. 220; Nobre, 1937, p. 8.

The only specimen known of this cephalopod was taken within sight of Madeira by the French naturalist Dussumier and was confused with *T. pavo* by d'Orbigny. Later Rochebrune demonstrated that it was a distinct species. A new description of this curious squid is greatly needed.

Order OCTOPODA

Family BOLITAENIDAE

Japetella diaphana Hoyle

Japetella diaphana, Thore, 1949, p. 23, fig. 14.

Bolitaenella diaphana, Nobre, 1937, p. 3.

Material seen :

No. 2958, 4 specimens, total length *ca.* 50 mm., stomach of *Alepisaurus ferox*, March-April, 1944.

No. 3357, 1 specimen, total length *ca.* 50 mm., from stomach of *Alepisaurus ferox*, 8. iv. 1952.

No. 3495, 2 specimens, total length of 50 and 70 mm., stomach of *Alepisaurus ferox*.

No. 3496, 1 specimen, total length 70 mm., ? stomach of *Alepisaurus ferox*.

No. 3569, 2 specimens, total lengths 55 and 80 mm., stomach of *Alepisaurus ferox*, 4. xii. 1952.

No. 3594, 1 specimen, total length 65-70 mm., stomach of *Alepisaurus ferox*, 1. iii. 1953.

No. 3903, 1 damaged specimen, total length 85 mm., stomach of *Alepisaurus ferox*, 26. x. 1953.

There are numerous records of this pelagic octopod in the North Atlantic, in the triangle, Canaries, Gibraltar, Azores (Thore, 1949, fig. 14, p. 23), but the first positive records from Madeiran fishing grounds are given above.

Bouxin & Legendre (1936, p. 12) reported finding this species (one specimen in each of three stomachs) in the germon (*Germo alalunga*) captured in the Bay of Biscay. It is now recorded for the first time from *Alepisaurus ferox* and appears to be a regular item in the diet of this fish.

For the *Bolitaenella diaphana* of Nobre, see *Eledonella pygmaea*.

Eledonella pygmaea Verrill

Eledonella diaphana, Joubin, 1900, p. 37, pl. 2, figs. 5-7.

Material seen :

No. 3800, 1 ♀ total length 150 mm., from the stomach of *Alepisaurus ferox*, no date.

Eledonella pygmaea is less common than the preceding species. It has not previously been recorded from Madeira or from the stomach of *Alepisaurus ferox*.

The "Princess Alice" (Joubin, 1900) took this species between Madeira and the African coast and there are more recent records of specimens taken by the "Dana" to the west and north of the Madeiran archipelago (Thore, 1949, fig. 41, p. 49).

Family VITRELEDONELLIDAE

Vitreledonella richardi Joubin

Vitreledonella alberti Joubin, 1924, p. 38 ; Nobre, 1937, p. 3.

This species had been included in a list of Madeiran cephalopods by Nobre (1937), who quotes Joubin's record of a specimen taken to the N.W. of Madeira (position, 33° 40' N. to 33° 52' N., 19° W. to 19° 16' W.) by the Prince of Monaco.

Family OCTOPODIDAE

Octopus vulgaris Lamarck

Octopus vulgaris, White and Johnson, 1860 ; Johnson, 1885 ; Girard, 1892, p. 218 ; Watson, 1897, p. 296 ; Nobre, 1937, p. 3.

Octopus tuberculatus, Girard, 1892, p. 218 ; Nobre, 1937, p. 4.

Octopus rugosus, Robson, 1929.

Material seen :

British Museum :

B.M. No. 1898.5.10.2, Porto Santo, Madeira, Coll. H. S. Wellcombe (Robson, 1929, as *O. rugosus*).

B.M. No. 1912.12.31.118-119, Porto Santo, Madeira, 60 fms., R. Kirkpatrick (Robson, 1929, as *O. rugosus*).

Funchal Market from mouth of *Conger conger*, 18.viii.1953, Coll. D. W. Tucker.

Funchal from a tide pool, 28.viii.1953, Coll. D. W. Tucker.

Funchal Museum :

No. 2460, 1 post-larva.

No. 140, 1 specimen, dorsal mantle length 90 mm.

No. 3287, from the stomach of *Aphanopus carbo*.*

The common octopus, which goes by the local name of *polvo*, is very common all the year round at Madeira and is on sale in the fish market. The fact that it is eaten by the local population may account for the scarcity of specimens available for examination. It is found, too, at the Cape Verde Islands, the Canaries and the Azores. Juvenile octopods mentioned under the name *Octopus tuberculatus* seem to belong to *O. vulgaris*.

Octopus macropus Risso

Octopus cuvieri, Girard, 1892, p. 219; White & Johnson, 1860; Nobre, 1937, p. 4.

Material seen :

Funchal Museum,—

No. 39, 1 ♀, total length 475 mm., Câmara de Lobos, 30.xi.1940.

No. 139, 1 ♂, total length 1,010 mm.—no date.

No. 2460, 2 juveniles in *alderi* stage—no date.

No. 3390, 1 ♂, total length 550 mm.—no date.

No. 3493, 1 juvenile in the *alderi* stage, from the stomach of *Alepisaurus ferox*.

This species was originally listed as occurring at Madeira in White & Johnson's *Handbook*, but the name was omitted in the second edition (1885). Subsequent authors have not recorded new material, so that evidence of its occurrence at Madeira was needed. The new records given above dispel this doubt and confirm its presence at Madeira.

Octopus sp.

Material seen :

No. 2960, 1 partly-digested specimen with a total length of 120 mm., from the stomach of *Alepisaurus ferox*, March-April, 1944.

No. 3504, 1 specimen from stomach of *Conger conger* (L.), 18.vii.1952.

No. 3577, 1 specimen with a dorsal mantle length of 14 mm., from stomach of *Alepisaurus ferox*, 10.xii.1952.

It has not been possible to positively identify these specimens with either of the foregoing species or any other, because of their immaturity and poor condition.

* From the stomach of *Aphanopus carbo* according to a fish gutter

Family ALLOPOSIDAE

Alloposus mollis Verrill

Material seen :

No. 2460, 1 ♀, total length 115 mm., March–April, 1944.

No. 2960, 1 ♀, total length 115 mm., stomach of *Alepisaurus ferox*.

No. 3491, 5 ♀, total lengths of 80, 115, 115, 115 and 117 mm., from stomach of *Alepisaurus ferox*, no date.

No. 3494, 1 ♀, total length 175 mm., stomach of *Alepisaurus ferox*, no date.

No. 3804, 1 ♀, total length 115 mm., stomach of *Alepisaurus ferox*, 12.vi.1953.

No. 3848, 1 ♀, total length of 50 mm., stomach of *Alepisaurus ferox*, no date.

This species has not been previously recorded from Madeira, but has been taken at the Azores and other places in the North Atlantic, mainly in proximity to coastal waters. Thore, who plotted its distribution (1949, fig. 69, p. 72), regards it as a cosmopolitan, tropical and sub-tropical coast-loving species.

The series now reported from Madeira are all small females (50–175 mm. in total length, compared with Verrill's specimen of 812 mm.) (Verrill, 1882). The paucity of records of *Alloposus* are noted by Thore, who suggests that either it is a rare animal or is able to evade plankton nets or spends "relatively short periods of its life-cycle in open waters, then soon returning to a life at the bottom, especially on the continental slopes." These new records suggest that the species is by no means as rare as the literature suggests and that we lack the gear to take it in numbers. At the smaller sizes (50–175 mm.) it seems to be a regular item in the diet of *Alepisaurus ferox*.

Family TREMOCTOPODIDAE

Tremoctopus violaceus delle Chiaje

Material seen :

No. 3404, 1 ♀, total length 480 mm.

No. 3406, 1 ♀, total length 510 mm.

No. 3408, 1 ♀, total length 305 mm.

There are no previous records of *Tremoctopus* from Madeira. It is well known from the Mediterranean but records from the North Atlantic are remarkably few (these are summarized by Robson, 1932, and Salisbury, 1953).

Family OCYTHOIDAE

Ocythoe tuberculata Rafinesque

Ocythoë tuberculata, Girard, 1892, p. 218; Robson, 1932, p. 202.

Oxythoë tuberculata Nobre, 1937, p. 4.

Material seen :

1 ♀, British Museum, No. 1858.3.31.6 (Robson, 1932).

No. 2460, 1 ♀, total length 115 mm. (33 mm. DML), no data.

No. 3440, 1 ♀, dorsal mantle length of 190 mm.—no data.

No. 3441, 1 ♀, dorsal mantle length of 180 mm.—no data.

No. 3492, 1 ♀, dorsal mantle length of 50 mm., from the stomach of *Alepisaurus ferox*.

No. 3848, 1 ♀, dorsal mantle length of 12 mm., from the stomach of *Alepisaurus ferox*.

Girard records having seen a specimen of this species in the Museu do Seminário do Funchal and there is another in the British Museum.

There are two large specimens noted here (Nos. 3440 and 3441); They compare favourably in size with one reported by Berry (1916) from California. Large as these are, Robson (1932, p. 205) records having seen one of 280 mm. (DML) at Monaco.

The young ♀ specimen (No. 3492) has a total length of 195 mm., and is remarkably well preserved. The tubercles, connected by ridges, on the ventral side of the mantle, are well developed and the aquiferous pores prominent. In another, even smaller specimen (No. 2460), these characteristics are easily seen.

Ocythoë tuberculata is another cosmopolitan species in tropical and sub-tropical waters of all oceans; as far as we know, it is essentially a species which frequents the surface layers. Bouxin & Legendre (1936, p. p. 31) found it in the stomach of the germon in the Bay of Biscay, while Joubin (1900, p. 26) reported three females from the stomach of *Grampus griseus* taken off Monaco.

It is now recorded for the first time as an item in the diet of *Alepisaurus ferox*.

Family ARGONAUTIDAE

Argonauta argo L.

Argonauta argo, Girard, 1892, p. 218; Hoyle, 1885, p. 69; Watson, 1897, p. 274; Nobre, 1937, p. 5.

Material seen:

No. 3489, 1 juvenile ♀, dorsal mantle length 37 mm., no data.

Early records from Madeira and Porto Santo are noted by Girard and Hoyle respectively, and it is not surprising that this cosmopolitan, warm-water species should be found here.

A juvenile female (without shell) is provisionally referred to this species. Watson (1897, p. 274) records one perfect specimen from Porto Santo, and by this we assume (as he was a conchologist) a shell or brood chamber.

Females of about 20–100 mm. in dorsal mantle length are found in great quantities in the stomachs of *Alepisaurus ferox* at Madeira during the months of March, April and May. There is one record for February and another of a single specimen in November. The shells are usually crushed, but sometimes they are quite intact. Eggs have been seen in shells of not more than 50 mm. in diameter. There is, in addition, a single record of a small female (of about 35 mm. in shell diameter) caught in Funchal Harbour at night. Large empty shells are not uncommonly found washed up on the beach of Porto Santo.

IV. AN ANALYSIS OF THE CEPHALOPOD-FAUNA

Surrounded as it is by deep water, the Madeiran Archipelago has a composite fauna with elements from different habitats. In general, the fauna may be said to be a Mediterranean-Atlantic one, which we group as follows :

1. *The coastal fauna*

This includes both littoral and continental shelf species, viz : *Sepia officinalis*, *Sepietta oweniana*, *Loligo vulgaris*, *Loligo forbesi*, *Todarodes sagittatus*, *Octopus vulgaris* and *O. macropus*.

All these are common also in the Mediterranean and eastern Atlantic. Only the two species of *Octopus* have a wider distribution in the Atlantic and elsewhere.

2. *The benthic slope fauna*

No Madeiran representatives of this fauna have yet been taken. The deep-water octopods of the genus *Bathypolypus* are typical examples of species found on the bottom below the 200 m. line.

3. *The bathypelagic slope fauna*

In the grouping of these species we are on less sure ground because of the scarcity of locality and depth records. Despite this we believe that the normal habitat of the adults of the species enumerated below is close to the bottom on the continental slope below the 200 m. line, with a lower limit perhaps at 2,000 m.

Spirula spirula.
Lepidoteuthis grimaldi.
Cuciotheuthis unguiculata.
Tetronychoteuthis dussumieri.
Architeuthis sp.
Histioteuthis bonelliana.
Ommastrephes pteropus.

4. *The pelagic surface fauna*

By these we mean the species that are habitually found on or very close to the surface. They include :

Ommastrephes pteropus (juveniles).
Onychoteuthis banksi.
Tremoctopus violaceus.
Ocythoë tuberculata.
Argonauta argo.

And possibly also

Thysanoteuthis rhombus.

5. *The epipelagic fauna*

In grouping pelagic forms we have to remember that many species have epipelagic larvae while the adults may live well below the threshold of light. Upwelling from deep water on some coasts and near oceanic islands sometimes brings characteristically deep-water species to the surface and it is not always possible to reach positive conclusions.

The following oceanic species appear to live in the upper 500 metres :

- Heteroteuthis dispar.*
- Abralia veranyi.*
- ? *Enoploteuthis leptura.*
- Pyroteuthis margaritifera.*
- Chiroteuthis veranyi* (? juveniles only).
- Leachia cyclura* (juveniles).
- Cranchia scabra.*
- Japetella diaphana* (juveniles).
- Alloposus mollis* (some part of its life history).

6. *The oceanic bathypelagic fauna*

These include deep-water species which live at or below the threshold of light (*ca.* 700 m.) and which are not confined to the immediate vicinity of the continental slope. These species often have larvae which are epipelagic.

- Chiroteuthis veranyi* (adult).
- Mastigoteuthis schmidti.*
- Leachia cyclura* (adult).
- Taonius pavo.*
- Japetella diaphana.*
- Eledonella pygmaea.*
- Vitreledonella richardi.*

We think that the occurrence of these species in the Madeiran list is probably due to the fact that there is upwelling which brings them into the upper waters or into the hunting grounds of *Alepisaurus*.

7. *The abyssal fauna*

Truly abyssal forms like *Vampyroteuthis infernalis* Chun have not been taken at Madeira.

In drawing up these lists we have paid but little attention to early records made with open nets from deep water. All too often when a plankton haul has been made with an open net from great depths (say 3,000 m.) to the surface, the resulting catch is reported as from 3,000 metres.

It has been clear for some time, too, that among the Cephalopods, larvae and adults do not always have the same vertical distribution, so that an animal may be a temporary inhabitant of several distinct faunal zones during the course of its life

history. Concerning vertical migration or diurnal rhythms in Cephalopods, we have no evidence, nor do we know how tolerant they are of changes in salinity. We do know, however, that some species are sensitive to changes in temperature and that a rapid lowering of temperature by two or three degrees is sufficient to kill some forms (e.g. *Architeuthis* and *Sepia officinalis*).

The above is in broad outline a reasonable grouping of the species, but more exact limits may be possible when we know much more about this group. It must be admitted, for instance, that it is not easy to decide whether the distinction between a bathypelagic slope fauna and an oceanic bathypelagic fauna can be maintained.

As the Madeiran Archipelago is the nearest oceanic group of islands to the Mediterranean, it may be pertinent to note that the following species in the list do not occur there :

Slope animals.	Bathypelagic species.
<i>Spirula spirula.</i>	<i>Mastigoteuthis schmidti.</i>
<i>Lepidoteuthis grimaldi</i>	? <i>Leachia cyclura.</i>
<i>Cucoteuthis unguiculata.</i>	<i>Taonius cymoctypus.</i>
<i>Enoploteuthis leptura.</i>	<i>Taonius pavo.</i>
<i>Tetronychoteuthis dussumieri.</i>	<i>Cranchia scabra.</i>
<i>Architeuthis</i> spp.	<i>Japetella diaphana.</i> ¹
	<i>Eledonella pygmaea.</i>
	<i>Vitreledonella richardi.</i>

Only two of the species, which may be termed slope and bathypelagic species, *Histioteuthis bonelliana* and *Chiroteuthis veranyi*, are found, and are known to breed, in the western Mediterranean. In this area the chief captures have been reported from places like Villefranche-sur-mer and Messina; that is, where upwelling from deep waters occurs.

It is inappropriate here to discuss the cephalopods of the Mediterranean fauna at length, but it can be said that it is poor in bathypelagic species; this is in agreement with what is known concerning the paucity of deep water species of other groups of animals (Ekman, 1953, p. 369).

V. CEPHALOPODA AS FOOD OF *ALEPISAURUS FEROX*

Alepisaurus ferox Lowe is well known as a voracious fish, and it has been known as a predator on squid since Verrill (1880, p. 234) described a brachial crown of *Histioteuthis* from a fish captured off Nova Scotia in 1879.

Examination of this series of 260 stomachs from Madeiran fishing grounds has yielded many comparatively rare species of squids which are not normally captured by plankton nets. The total of 18 species demonstrates that cephalopods can be regarded as regular items in the diet of this fish :

¹ "Dana" St. 1132, 36°, 10' N., 2° 46' W. in the Western Mediterranean near Gibraltar did yield one larval *diaphana* of 12 mm. (Thore, 1949, p. 28). We concur with Thore that this juvenile specimen was probably swept in through the Straits of Gibraltar in the easterly surface current.

LIST OF SPECIES EATEN

Species.	Total number.	Max. number in one stomach.	Number of stomachs containing cephalopods.	D.M.L.
<i>Heteroteuthis dispar</i> . . .	8	4	4	8-29
<i>Loligo vulgaris</i> . . .	1	1	1	7
<i>Abraliopsis morisii</i> . . .	6	6	1	8-25
<i>Pyroteuthis margaritifera</i> . . .	2	2	1	35
<i>Onychoteuthis banksi</i> . . .	6	4	3	10-48
<i>Todarodes sagittatus</i> . . .	3	1	3	83-86
<i>Ommastrephes pteropus</i> . . .	1	1	1	50
<i>Ommastrephids</i> . . .	5	3	3	17-65
<i>Leachia cyclura</i> . . .	2	1	2	23-50
<i>Cranchia scabra</i> . . .	2	1	2	39-40
<i>Taonius pavo</i> . . .	1	1	1	275
<i>Japetella diaphana</i> . . .	13	4	8	50-85
<i>Eledonella pygmaea</i> . . .	1	1	1	90
<i>Octopus macropus</i> . . .	1	1	1	22
<i>Octopus</i> sp. . . .	1	1	1	15
<i>Alloposus mollis</i> . . .	9	5	5	30-40
<i>Ocythoë tuberculata</i> . . .	2	1	2	12-50
<i>Argonauta argo</i> (see text) . . .				20-100

The dorsal mantle length has been taken as a standard measurement for size, and as a rough guide this is about half the total length of the animal in compact species like *Heteroteuthis dispar*, *Abraliopsis morisii*, *Pyroteuthis margaritifera*, *Cranchia scabra*, *Japetella diaphana*, *Eledonella pygmaea*, *Alloposus* and *Ocythoë*. It represents about only a third of that of *Histioteuthis bonelliana*, where the body is small and the arms disproportionately large. In the long and typical squids like *Loligo*, *Onychoteuthis*, *Todarodes*, *Leachia* and *Taonius*, mantle length is usually more than half the total length.

Japetella diaphana, *Alloposus mollis* and *Heteroteuthis dispar* are the species most frequently represented and are perhaps rather sluggish creatures. It is particularly noticeable that among the swift-moving species the specimens of *Onychoteuthis banksi* were rather small, several being still in the planktonic stage.

As will have been noted already, none of the cephalopods from the stomach of this fish can be regarded as truly deep-water species in the sense that this term can be applied to forms like *Vampyroteuthis infernalis*. All might reasonably be expected to occur in the upper 200 metres—the depth at which the fish were caught.

Of the eighteen species, only four, namely *Loligo vulgaris*, *Todarodes sagittatus*, *Japetella diaphana*, *Octopus macropus* and *Argonauta argo* are common species in collections. Of the remainder there is little doubt that they are also common species, although records of capture are few. It is only recently that *Japetella diaphana* has been demonstrated to be one of the most abundant pelagic species of cephalopod (Thore, 1949), and Joubin (1933, p. 41) has similarly indicated from a preliminary examination of the "Dana" collections that the Cranchiidae (to which *Leachia*

cyclura, *Cranchia scabra* and *Taonius pavo* belong) are also very numerous. Records of *Ocythoë tuberculata* (and possibly also *Alloposus mollis* to a lesser degree) are very few and do not imply scarcity but rather that the fishing gear hitherto employed by expeditions is unsuitable for capturing animals of this group. The same difficulty applies to the capture of swift surface species like *Onychoteuthis banksi* (Rees, 1949).

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